

BIOLOGY OF ARIZONA TERMITES WITH EMPHASIS ON SWARMING

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The biology of most of the species of termites occurring in the United States is very imperfectly known. Records as to time and manner of swarming are few and incomplete or of local significance. Much of the information available is found in Snyder's account (1920 a) of the biology of the Nearctic termites. For the few economically important western species relatively complete accounts are found in Kofoid, Light, et al (1934).

The present studies were made during the spring and summer of 1946 while conducting laboratory studies of the higher termites in Arizona (Light and Weesner, 1947 a, b). Headquarters was near the upper altitudinal limit of the range of these termites at the 5000 ft. level in Miller Canyon, on the eastern slope of the Huachuca Mountains, Cochise County. This is in the lowermost oak zone (encinal) where it meets an extension of the great plains grasslands in the San Pedro valley.

While at this location and during field trips to other localities observations were made on the biology of the following species, with emphasis on the three species of Termitidae:

FAMILY KALOTERMITIDAE

Zootermopsis laticeps (Banks) 1906.

Paraneotermes simplicicornis (Banks) 1920.

Kaloterme hubbardi Banks 1920.

Kaloterme minor Hagen 1858, Banks 1920.

FAMILY RHINOTERMITIDAE

Reticulitermes tibialis Banks 1920.

Heterotermes hoferi (Banks) 1920.

FAMILY TERMITIDAE

Gnathamitermes perplexus (Banks) 1920.

Amitermes wheeleri (Desneux) 1905.

Tenuirostritermes tenuirostris (Desneux) 1904.

Unless otherwise stated the records given below are for the zone from 4500 to 5000 feet near Miller Canyon, Huachuca Mountains, Cochise County, Arizona, summer of 1946. Reports of present status of cultured incipient colonies and groups are for March, 1947.

ZOOTERMOPSIS LATICEPS (Banks)

Termopsis laticeps Banks 1906, 1920.

Zootermopsis laticeps (Banks), Emerson 1933, Sumner 1933.

Winged adults are reported by Snyder (1920) to have been taken at Garcie and Palmerlee, Arizona, in June and July, and in the Santa Rita and Santa Catalina Mts., Arizona, in July. Snyder says "this termite swarms in June or July."

No colony of this rare species was encountered by us but alates were taken by the junior author at the lantern and at lighted windows on two successive nights. They appeared singly and at intervals from 1 A.M. to 4 A.M. on July 4, a warm night but without rain. Six alates were taken at intervals at the lantern the next night from 11 P.M. to 12:45 A.M., again a warm night with no rain. These alates are slow, strong fliers.

Attempts to rear incipient colonies of *Z. laticeps* were unsuccessful although its two coastal congeners lend themselves readily to culture.

PARANEOTERMES SIMPLICICORNIS (Banks), Light 1934

Kaloterme simplicicornis Banks, 1920, p. 32, Snyder 1926, Light 1926 a, 1927.

Cryptotermes infumatus Banks, 1930, p. 38.

Neotermes simplicicornis Banks, Light 1929 a, b; 1930.

Kaloterme (Neotermes) simplicicornis Banks, Cupp 1930, Light 1931.

Kaloterme (?) *simplicicornis* Banks, Light 1933.

Paraneotermes simplicicornis Banks, Light 1934 a.

Kaloterme (Paraneotermes) simplicicornis Banks, Light 1937.

There are no published records of natural swarming. Light (1937) reports finding alates in colonies in the Coachella Valley, San Bernardino County, California, in October and November and describes their flight from the opened workings. There had been no rain in that locality for more than a year which probably accounted for their presence in the colony so late. Both their coloration and behavior indicate that they are day fliers.

A large colony, taken by us at Fairbanks, Cochise County, Arizona, on May 2, contained many brachypterous nymphs but no alates. An alate appeared early in June in cultures set from this group. On June 27 alates were found to be numerous in two of the groups and presumably they were present in field colonies at least by that time.

A large colony which was opened by the junior author at 9:30 A.M., July 19, at Coldwater near Phoenix, emitted a swarm of alates which flew off rapidly. There had been a heavy rain the night before and it seems probable these would have swarmed later that day.

Primary pairs did not flourish in culture. Several have persisted for more than eight months, and eggs have been recorded from time to time. Two of them contain eggs at present and one contains a medium sized nymph. Young were recorded in three other colonies about 100 days after setting. No pair developed a normal incipient colony.

Groups of nymphs of this species did not prove to be good subjects for laboratory culture. Most groups were closed out at the end of ten weeks at which time the population surviving was low, ranging from 30% to 55%. One to three supplementaries per group were recorded five weeks after setting and eggs were seen in some groups two weeks later. No young were reported in groups of this series in which the groups consisted of 17 nymphs each. One larger group of 60 nymphs and 10 soldiers, set May 2, is flourishing. It was set in a three-ounce jar with wood blocks covered with loose moistened soil of origin. Supplementaries were first seen in this group June 27 and eggs on July 18. At present visibility is not good but numerous young nymphs of several instars are to be seen and probably there are eggs.

KALOTERMES HUBBARDI Banks 1920

Snyder (1920) records alates taken flying in Sabino Canyon, Pima County, Arizona, from June 20 to July 28, 1918, and again June 30 to August 28, 1919, at lights. He also reports them at Tucson and Redington, Arizona, in July. Presumably this very light-colored species is always typically a night flyer.

They emerged in numbers, during the late evening of July 14 from heavily infested dead cottonwood stubs collected at St. David,

Cochise County, Arizona, on April 30 and kept on the porch of the laboratory.

The junior author observed alates in colonies in giant cactus near Phoenix on July 19. There had been a heavy rain the night before and they were found in flight at 8:30 P.M. that night near Mesa. The swarming alates were very numerous, collecting about lights.

Incipient colonies were cultured with indifferent success. Of six persisting, four contain nymphs but only about two per colony.

Groups of nymphs of this species were cultivated with marked success and are doing very well both in the original cultures and after transfer to new culture jars. Our results indicate that it is much the most favorable species of *Kaloterme*s for laboratory experiments.

Supplementaries were produced in laboratory groups, the first after 23 days. However, with one doubtful exception no eggs have been recorded.

KALOTERMES MINOR Hagen 1858, Banks 1920

*Caloterme*s *marginipennis* Latreille, Hagen 1858, p. 47, "Variet. Minor," ("Californien").

*Caloterme*s *marginipennis* Latr. Hagen, 1860 p. 100, "Var. Minor" in text; ("Aus Californien" . . . von *San Diego*").

*Caloterme*s *marginipennis* ! Hagen 1861, p. 2, "Var." ("San Francisco and San Diego, California").

? *Caloterme*s *castaneus* Bermeister, Hagen 1858, p. 38 ("Kalifornien (San Francisco)").

? *Caloterme*s *castaneus* !, Hagen 1861, p. ("San Francisco, California (Chamisso)").

*Kaloterme*s *minor* Hagen, Banks 1920, Snyder 1926, Light 1926 b, 1929 a, 1930 a, 1933, 1934 a, Hendee 1933.

Snyder reports flights in July in Arizona and that the alates were taken at lights frequently with *K. hubbardi*, in Sabino Canyon, Arizona. Harvey's extensive records (Kofoid, Light et al, 1934) show the species to be a day flyer in southern California as its dark color would indicate it to be normally. Brilliant sunshine and temperatures from 80° to 100° F. were found by Harvey to be conditions requisite for flight. Swarms were recorded for southern California from late September to early November, chiefly in the middle of the day from 11:30 A.M. to 3 P.M. A careful study might

show the night fliers in Arizona to be late stragglers from heavier daylight swarming.

We found this termite to be common in the walnuts and sycamores of the canyons and washes of southeastern Arizona. Alates were found in colonies in sycamores on July 5 but we observed no flights.

Primary pairs taken from colonies responded poorly to culture. No pair developed a normal incipient colony. All but one of the persisting pairs produced eggs at some time but only a few young were known to have been produced and only in two groups.

RETICULITERMES TIBIALIS Banks, 1920

Reticulitermes humilis Banks 1920 (ex parte).

R. humilis Banks, Light 1933, 1934 b, Snyder 1926, 1934 (in Kofoid, Light et al).

R. humilis Banks, Light 1933.

Nec *R. humilis* Banks var. *Hoferi* Banks 1920 (see *Heterotermes hoferi* (Banks)).

Nec *R. humilis* Banks 1920 from Tucson and fig. 38, (see *Heterotermes hoferi*).

R. tibialis Banks 1920, Snyder 1920 a, Light 1929 a, 1930 a, 1931, 1933, Pickens 1934 (in Kofoid, Light et al), Snyder 1934 (in Kofoid, Light et al).

Emerson (personal communication) considers *R. humilis* Banks to be a synonym of *R. tibialis* Banks whose very great range, California to Illinois, makes it seem probable that it will prove to be a Rassenkreis of which *R. humilis* may represent one subspecies.

This termite, abundant in fence posts, oak stubs, etc., in southeastern Arizona was little studied by us. No flights were observed by us nor were alates found in the colonies opened. Our attention was largely directed toward the higher termites and we might well have missed a flight. The only colony at all fully collected was taken early in March. It contained many large brachypterous nymphs at about the stage of those found in colonies of Termitidae at the same date and which in these colonies developed into alates in late May. In California alates of *R. tibialis* emerge with the rains as do those of *R. hesperus*. There the rains come in the fall. Spring, summer and fall flights of *R. tibialis* have been reported by Snyder (1920), that for Arizona in July, and Snyder (1920) reports that *R. humilis* (= *R. tibialis* of Arizona), "swarms during the last of June or July," his reports being from Arizona.

A large series of groups from one colony proved this species to be an even better laboratory animal than its congener *R. hesperus*. Of the 56 groups set only two died out after 5 months. From 1 to 3 brachypterous supplementaries were produced after 35 days in each of 18 groups each of which contained 4 brachypterous nymphs. A single supplementary was present in one group of apterous individuals after 63 days. At the end of 5 months they were present in only half of the apterous groups. The supplementaries which were produced in them were apterous, presumably from late pre-worker apterous nymphs. The possibility remains that workers of this species may become supplementaries; workers and late apterous nymphs are hardly distinguishable. Pickens (1932) found the same delayed production of apterous supplementaries in groups of apterous individuals.

Eggs and young were produced much earlier and in greater numbers in the groups containing brachypterous supplementaries than in those groups composed entirely of apterous individuals.

HETEROTERMES HOFERI (Banks) 1920, Snyder 1926

Reticulitermes humilis Banks var. *Hoferi* Banks 1920, Snyder 1920.

Reticulitermes hoferi Snyder 1926 p. 392.

R. humilis Banks 1920 (ex parte, Tucson and Lower records; fig. 38, 1).

R. aureus Snyder 1920 b.

Leucotermes aureus Snyder 1926, Light 1929 b.

Heterotermes aureus Snyder, Light 1930 a, 1933, 1934, Pickens and Light 1934 (in Kofoid, Light et al).

There seems no doubt that the soldiers allocated by Banks (1920, p. 53) to "*Reticulitermes humilis* Banks var. *Hoferi* new variety" are the soldiers of the only species of *Heterotermes* occurring in the United States. The specific name *hoferi* Banks, February 15, 1920, has precedence over Snyder's name *Reticulitermes aureus* February 18, 1920, given to the alates of the same species as Snyder himself points out (1926, p. 392).

This species, not present near headquarters, was collected by the junior author at Apache Junction and near Mesa, Maricopa County, Arizona, on July 19 and 20. No alates were present in the 10 colonies observed at Apache Junction, including a very large colony collected for use in setting up laboratory groups. This large colony

did not include brachypterous nymphs nor were they recorded for the other colonies. It seems probable, therefore, that the flight had already occurred in this locality. Alates were seen, however, in two colonies out of 8 south of Mesa on July 20, which was the day after the first heavy rain of the season.

Light (1932) reported alates of *Heterotermes aureus* taken with *Amitermes perplexus* ("*Amitermes magnoculus*" Light) at Calexico, California, between 7 and 8 P.M. September 11, 1930, a very dry year, following a hard rain from 4:15 to 5 P.M. Again in 1931 the two were taken together at the same place in the evening of August 4 following a gentle rain.

Numerous eggs were produced in each of three incipient colonies set and young developed. The persisting colony was transferred to a new culture vial on the 9th of January. It contains three young in a late instar and one egg.

The large colony collected in a smokewood tree near Apache Junction was used to set 100 groups of apterous individuals supposedly largely workers. Various culture methods were used. Smokewood chips or sawdust was used for food in sixty of the hundred since it was the wood of origin. This proved unfortunate since in all of these cultures a scum appeared on the agar surface accompanied by a foul odor; the termites died rapidly and a heavy fungus growth occurred. The forty groups cultured in the standard sawdust (Light and Weesner, 1947 a) flourished. Of these ten have been kept, a few in the same cultures, others transferred to new cultures, and are doing well.

At no time have supplementary reproductives, eggs or brachypterous nymphs been seen in any of these groups although they were set up eight months ago.

GNATHAMITERMES PERPLEXUS (Banks)

Termes tubiformans Buckley, Desneux 1905; nec *Termes tubiformans* Buckley 1863.

Amitermes perplexus Banks 1920.

A. confusus Banks 1920, Light 1934 a.

A. arizonensis Banks, Light 1930 a, 1931.

Amitermes (*Gnathamitermes*) *perplexus* Banks, Light 1932, 1934 a, b.

A. (G.) acutus Light 1932, 1934 a.

A. (G.) acrognathus Light 1932, 1934 a.

A. (G.) fuscus Light 1932, 1934 a.

A. (G.) infumatus Light 1932, 1933, 1934 a.

A. (G.) confusus Banks, Light 1932, 1934 a.

A. (G.) magnoculus Light 1932, 1934 a.

Light (1932) described several of the varieties of this wide ranging species as separate but closely related species. However, continued study of growing collections made it increasingly probable that these are varieties rather than species. The senior author now agrees with Emerson (in litt.) that but two species of *Gnathamitermes* are known from the United States, *Gnathamitermes tubiformans* (Buckley) and *G. perplexus* (Banks).

A. arizonensis Banks 1920 included soldiers of this species but was based on alates of *A. wheeleri* (Desneux) as shown by Light (1932), leaving *A. perplexus* Banks 1920 as the name for the common desert termite of southern California, Arizona, New Mexico, Texas and northern Mexico (Light 1933). Two additional species, *G. grandis* Light (1930 b) and *G. nigriceps* (Light 1930 b) occur in Mexico and have not been reported from the United States.

Large brachypterous nymphs later to molt into the summer's alates were present from our arrival in early March. Eggs were first recorded on April 25, callows (from the apterous nymphs of the previous year) on April 5, soldier nymphs and callow soldiers (from the previous year's brood) on May 15, young on May 1 (first instars only), young brachypterous nymphs on June 20.

Numerous alates were present in at least one colony on June 1 and they were found in colonies until the middle of July. On June 6 they were seen in 8 out of 10 colonies opened and were probably present in most of the colonies at that date.

Numerous records (Snyder 1920, Light 1932, pp. 397, 407) show *G. perplexus* to have been taken in flight in late June or July, usually in the evening after rain. However, one record had them flying at 9:15 in the morning, another from 2 to 4 P.M. during a steady rain.

Five flights were recorded in the vicinity of headquarters and another at Phoenix as follows:

(1) June 16, a few taken on windshields and others seen in flight in light of headlights after dark, about 8 P.M. during a light shower after a fairly heavy short afternoon rain.

(2) July 2, emerging from crack in concrete bottom of old swimming pool at 3:30 P.M. during light rain (mostly killed and carried off by ants).

(3) One seen in flight somewhat later that afternoon on Highway 92 during a light rain.

(4) July 6, seen emerging from two holes in front of laboratory between 5:15 and 5:40 P.M. Workers and soldiers active at the emergence holes. Ground wet from shower at 4:45 P.M., probably very light rain at time of emergence. From numbers seen in flight there were evidently several other colonies swarming nearby, all within the live oak zone. Weak-looking, but actually effective flyers. Flying with wind toward the southeast. Some seen to alight and take off again. No dealation or pairing seen. Numbers small, emergences at intervals, flight long and desultory. Seems very improbable that pairing eventuated.

(5) July 12, heavy flight at 2:30 P.M. during slight showers following heavy rain at 2 P.M. Many were seen in flight as we drove down to Highway 92. Some were still flying along highway but most were already dealated on the ground. Numerous pairs seen, also singles. Some pairs were taken immediately under rock surfaces, some in shallow depressions under rocks where they had started to work in earth, and some in tunnels under rocks where they had burrowed an inch or more into soil. In numerous instances more than one pair were under the same rock and in several instances two pairs were burrowing in a common passage. This was probably the main flight in that area. No other flights were recorded there.

(6) July 19, Phoenix, about 100 seen in flight when sun broke through overhanging clouds at 6:30 A.M. Ground soaked and water standing in pools from an extremely heavy night rain, the first rain of the season in that vicinity.

The colonies of *Gnathamitermes* were to be found in earth under stones as was true of *Amitermes* and *Tenuirostritermes*. They evidently foraged widely through the soil, however, since they were found in a high percentage of the cowchips as was *Amitermes* but not *Tenuirostritermes*.

Many experiments were set up from *Gnathamitermes* colonies with a view to finding a satisfactory method of culturing groups

of the workers and apterous nymphs plus, in some instances, brachypterous nymphs. In general these attempts were not especially successful although many groups persisted up to more than two months and in the first such series more than three months. These experiments will be more fully reported elsewhere.

Brachypterous nymphs became pigmented supplementary reproductives in a number of laboratory groups. Both supplementaries and brachypterous nymphs were much more hardy than the workers and apterous nymphs and persisted long after the entire apterous population was dead.

In only one instance were eggs seen in these groups headed by experimentally produced supplementaries.

More than 400 incipient primary colonies were set up and some seemed to proceed normally. No soldiers nor workers developed, all individuals remaining in the late apterous nymphal stage. Detailed results will appear elsewhere.

AMITERMES WHEELERI (Desneux), Light 1932

Termes wheeleri Desneux 1905.

Amitermes arizonensis Banks 1920 (alates ex parte?).

A. californicus Banks 1920 (soldiers), Snyder 1926, Light 1930 a, b, c, 1931.

?*A. parvipunctus* Light 1932.

?*A. spadix* Light 1932.

A. (A.) wheeleri (Desneux) Light 1932 a, b.

Nec *Amitermes wheeleri* Desneux, Banks 1920 "Brownsville and San Antonio" (= *A. minimus* Light 1932).

Nec *A. wheeleri* Desneux, Snyder 1926, (= *A. minimus*).

Nec *A. wheeleri* Desneux, Light 1930 a, b, c, 1931 (= *A. minimus*).

This widespread and variable species is found living under a wide range of climatic conditions. Records of its biology are few and unreliable because of its checkered systematic history. Alates were taken by us in colonies on several occasions in flights. The alates taken on all occasions agreed as to color, size and general appearance. There is no question that these are the alates of *A. wheeleri* of this region. They differ in the generally darker color from the previously described alates of *A. wheeleri* (Light 1932). In life they gave the impression of being smoky black with gray-black wings. Fixed specimens show a brown color not noticeable in life. These were taken from a colony of June 1 the day when

alates were first recorded. It seems probable that they had not acquired full pigmentation. The head is a dark smoky brown, the pronotum slightly lighter, legs and outer antennae are smoky, postclypeus pale smoky, anteclypeus and labium pale yellow.

Most of the alates taken were used to set up incipient colonies. Only six alates from one colony were saved for study. Measurements of these show them to agree very well with the alates of *A. wheeleri* from Texas described by Light in 1932 and with *A. parvipunctus* Light (1932) and *A. spadix* Light (1932). They show considerable variation as to size and shape of the fontanel. It seems probable as indicated in the synonymy that *A. parvipunctus* and *A. spadix* are synonyms of *A. wheeleri*. The variation in markings of the head and pronotum and in the size and shape of the fontanel may not be significant and can only be evaluated by studies of large series. They may prove to be of subspecific value if, as seems probable, this wide-ranging species proves to consist of several subspecies. It ranges from the California desert eastward to Brownsville, Texas, and from Las Vegas, Nevada, southward at least as far as the city of Colima, Colima, Mexico (*A. californicus*, Light 1930).

A. pallidus differs in coloration and size from all the alates here assigned to *A. wheeleri* and must be considered to represent a different species.

Since *A. wheeleri* was smaller and less abundant than *G. perplexus*, the latter was studied more carefully and used more extensively in culture and experiments hence the records for *Amitermes wheeleri* are casual. Actually *A. wheeleri* proved much the better laboratory animal so far as group cultures were concerned whereas the incipient colonies of *G. perplexus* were much more successful in the laboratory than those of *A. wheeleri*.

The constitution of the colonies in March was the same as for *G. perplexus*. The large brachypterous nymphs which were to molt into alates in May or early June, were present presumably from the first but were first recorded on March 15. No supplementaries were found in colonies but brachypterous nymphs in experimental groups developed into dark brown supplementaries as they did in the two other species of Termitidae. The first was recorded 46 days after segregation of the group. Worker-like apterous nymphs were present in considerable numbers from our arrival in March, as in *G.*

perplexus, and could be distinguished from the workers but with more difficulty than in *Gnathamitermes*.

On June 1 alates of all three species were brought in from colonies. This was the first record of alates in a colony of *A. wheeleri*. Only a few were present in one colony and brachypterous nymphs were abundant whereas in *G. perplexus* at that time there were few brachypterous nymphs and alates predominated and in *Tenuirostritermes* there were many alates and no brachypterous nymphs.

Three flights were observed by the senior author all in mid July and all under similar conditions. They all occurred in late afternoon, from 5:30 to 7:15 P.M., when the sun broke through the clouds on days when earlier rains had wet the ground. The flight was general over the areas observed but was brief and terminated sharply when the sun went under a cloud or fell behind the mountains. The alates flew with the wind. They appeared feeble but were actually strong fliers. It was difficult to keep up with them by running. Some traveled at least several hundred yards. Several were seen to light and take off again. No dealated individuals or pairs were seen and it was difficult to conceive of many pairs together unless the flights are heavier as they may well have been at some swarming missed by us.

The first recorded flight was at 7:07 P.M. on July 12, when there was a heavy rain storm at 2:30 P.M. during which *G. perplexus* made its first recorded flight. The flight was general but was seen for only about 20 minutes, during which alates in flight while scattered were in sight in every direction. Some issued from holes very near those from which had issued the alates of the July 6 flight of *G. perplexus*.

On July 14 alates were first seen at 6:45 P.M. with a brisk wind blowing. The maximum flight began when the wind fell about 7:07. At one spot, supposedly a single colony, 16 holes of issue were counted and it was estimated that there were about 30 such holes. Each aperture was minute. As a rule only one alate issued at a time. The large number of holes may provide some safety from ants which were attacking them very actively.

The last flight on July 18, was observed to last only about 10 minutes, beginning everywhere within the range of vision a few minutes after the sun emerged and terminating at once when the sun fell behind the mountains. It had rained heavily the day before,

and there had been a slow shower earlier that afternoon. The temperature was low.

Amitermes wheeleri would seem on the basis of this slight evidence to differ from *G. perplexus* in swarming habits in that *A. wheeleri* is not dependent upon rain at the moment of flight but 1) is a diurnal flyer as its dark color would indicate but flies in the late afternoon or early evening, 2) is dependent upon moisture from recent rains, 3) flies during a brief period on any given day (because near the time of the setting of the sun), 4) is able to fly on relatively cold days but 5) is dependent upon the brief warming action of the sun.

TENUIROSTRITERMES TENUIROSTRIS (Desneux)

Termes tenuirostris Desneux 1904.

Constrictotermes tenuirostris Desneux, Banks 1920.

Nasutitermes (Tenuirostritermes) tenuirostris Desneux, Light 1934 in Kofoid, Light et al.

Nasutitermes (Tenuirostritermes) cinereus (Buckley) Light 1934 b.

Emerson, who will shortly publish a revision of *Tenuirostritermes*, has identified the Arizona species as the type species of the genus (personal communication). The biology of this species will be more fully reported later by the junior author.

Snyder (1920) reports that this species swarms at night. Most of his records are from the mountains of Arizona and all are for July except for one on June 25, 1899, in the Huachuca Mountains. Nothing is said as to temperature or relations to rainfall which according to the observations of the junior author are of limiting importance. Her observations are summarized below.

Alates were first seen in a colony on May 27. They were present in small numbers as late as August 7 in 3 out of 7 colonies in the lower pastures where rainfall was lighter.

Although only two swarmings are known to have taken place the conditions necessary for flight seem clear from the conditions known to have occurred during those two flights and those obtaining on the very many occasions when rains furnished the requisite moisture but no flight occurred. The essential conditions seem to be 1) maturity of the alates, presumably attained by the latter part of June, 2) a warm night rain, presumably a long soaking rain or a lighter rain following a previous wetting.

Observations in the field at all times of the day but especially at night on occasions from July 3 to August 1, during rains, after

rains, and when no rains had occurred, using the gasoline lantern at nights, were entirely without results except on the nights of July 10 and 21. These were nights of warm rains, 72° F. on July 10, whereas the other night rains were cold.

On July 10 the flight was heavy and presumably general. Alates were first seen flying to lighted windows situated 300 yards above the nearest colonies. They were seen to dealate and pair. Flight was observed to last from 10 P.M. to 10:45 P.M., during fairly heavy rain which began at 9:30. No flight was observed at the lantern during a similar rain the preceding night but this was the first rain for some time and the ground was dry.

After the rain stopped at 11 P.M. many wings were found on the ground where the colonies were located but no further flight was observed. The number of alates in colonies was considerably reduced after this date especially in the higher levels where rain fall was the greatest.

On July 21 it rained from 9 to 10 P.M. but no flight occurred. It rained again about 2 A.M. and then the flight presumably occurred since numerous wings were found in the lower pasture the next morning.

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